Published in final edited form as:
Drug Alcohol Depend. 2007 July 10; 89(2-3): 234–243.

Injecting and sexual risk correlates of HBV and HCV seroprevalence among new drug injectors

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Abstract

We examine injecting and sexual risk correlates of hepatitis B (HBV) and hepatitis C (HCV) seroprevalence among new injecting drug users (IDUs) (age 18–30 years, injecting ≤6 years). Participants were interviewed/serotested (HIVab, HBVcAb, HCVab) in New York City, 2/1999–2/2003. Gender-stratified, multivariate logistic regression was conducted. Participants (N=259) were: 68% male; 81% white. Women were more likely to test HCV seropositive (42% vs. 27%) and men HBV seropositive (24% vs. 12%); HIV seroprevalence was low (3%). Among both men and women, HBV seropositivity was associated with ever selling sex, and HCV seropositivity with ever having had infected (HIV, HBV or HCV) sex partners (among those ever sharing injecting equipment). Among women only, HBV seropositivity was associated with ever having had infected sex partners (regardless of ever sharing injecting equipment), and HCV seropositivity with ≥300 lifetime drug injections. Among men only, HCV seropositivity was associated with ≥40 lifetime number of sex partners (among those never sharing injecting equipment). In this new IDU sample, HBV and HCV seroprevalence differed by gender and were considerably higher than HIV seroprevalence. Early interventions, targeting injecting and sexual risks and including HBV vaccination, are needed among new IDUs to prevent HBV, HCV and, potentially, HIV epidemics.

Keywords

HIV; HBV; HCV; drug injectors; injecting risk; sexual risk

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1. Introduction

Many new injecting drug users (IDUs) are at risk of infection with HIV, the hepatitis B virus (HBV), and the hepatitis C virus (HCV) soon after initiating injecting (Friedman et al., 1989;Neaigus et al., 1996;Garfein et al., 1996;Hahn et al., 2001). However, while most new IDUs are uninfected with HIV in the first few years after initiating injecting, infection with HBV and HCV is widespread (Des Jarlais et al., 2003;European Centre for the Epidemiological Monitoring of AIDS. 2003). Not only are HBV and HCV more efficiently transmitted than HIV (Ippolito et al., 1999;Puro et al., 2001), but among new IDUs the probability of exposure to HBV and HCV is generally greater than the probability of exposure to HIV (Des Jarlais et al., 2003). Nevertheless, many of the risk factors for infection with HBV and HCV are also risk factors for infection with HIV. Examining the risk factors for HBV and HCV infection in low HIV-prevalence populations of new IDUs can provide sentinel indicators of HIV risk prior to the outbreak of an HIV epidemic, which can assist in developing early interventions.

Although new IDUs are at both injecting and sexual risk of infection with HIV and HBV, they have increasingly gained access to legal sources of sterile syringes and many have reduced the direct sharing of syringes (Des Jarlais et al., 2000;Emmanuelli and Desenclos, 2005). Nonetheless, sharing drug preparation equipment, such as cookers, is still common (Hagan et al., 2001). Sexual risk has also been more difficult to change (Neaigus et al., 1990;Semaan et al., 2002;Strathdee and Sherman, 2003) and new IDUs remain at sexual risk for HIV and HBV infection. New IDUs may also be at sexual risk of HCV infection—while HCV is mainly transmitted parenterally through blood-to-blood transmission, several studies have found evidence for the sexual transmission of HCV (Thomas et al., 1994;Ndimbie et al., 1996;Rooney and Gilson, 1998;Wejstal, 1999).

In the following, injecting and sexual risk correlates of HBV and HCV seroprevalence are examined in a low HIV-seroprevalence population of new IDUs. Since becoming infected requires both risk behaviors and exposure to infectious risk network members, i.e., those with whom new IDUs inject drugs and/or engage in sex (Neaigus et al., 1994), the analysis considers both risk behaviors and the characteristics of risk networks. Moreover, in addition to examining the main effects of injecting and sexual risks for infection, the overlap of injecting and sexual risks for each pathogen is analyzed by assessing interactions between injecting and sexual risk. The analysis is also stratified by gender, since women may become infected at a faster rate than men soon after initiating injecting. This may reflect both their increased risk of being exposed to older injecting and/or sex partners, who may be more likely to be infectious for HIV and hepatitis B or C (Nelson et al., 1995;Friedman et al., 1999;Doherty et al., 2000), as well as normative factors and social network influence from IDU sex partners that may increase female new IDUs' risk of sharing drug use equipment (Frajzyngier et al., in press;Neaigus et al. 1995;Evans et al., 2003), and possibly of engaging in unprotected sex. A gender stratified analysis is also appropriate because the risk factors for infection may differ by gender (Solomon et al., 1993).

2. Methods

2.1 Recruitment and procedures

Between February 1999 and February 2003, cross-sectional data were obtained from new IDUs recruited in the Lower East Side/East Village area of New York City for a study of behavioral and network risks for infection with HIV, HBV and HCV. Participants were non-drug-treatment recruited using targeted sampling, street outreach and chain-referral methods (Watters and Biernacki, 1989;Heckathorn, 1997;Sifaneck and Neaigus, 2001). Eligible participants were between 18 and 30 years of age, had initiated drug injecting within the prior six years, and had injected drugs (heroin, cocaine, or methamphetamines) within the prior 30

days. Drug use was verified through urine drug toxicology tests (Roche Abuscreen OnTrak) or a hair assay (radioimmunoassay by Psychemedics). To verify recent injecting, arms or other visible body sites were inspected for injecting marks. Those without visible marks indicating recent injecting were excluded from the study.

After providing their informed consent, eligible participants were administered, in private, a structured face-to-face interview, which was conducted in-person by a trained interviewer at a research site in the recruitment area. Following the interview participants were pre-test counseled for HIV, HBV and HCV and had blood specimens collected by a trained phlebotomist/counselor. Drug treatment and health and social service referrals were available. Those who returned for their test results and were HBV seronegative were referred to the New York City Department of Health HBV vaccination clinics. Participants were paid a small monetary incentive for their time and travel expenses. All procedures involving human subjects were reviewed by the Institutional Review Board at National Development and Research Institutes.

The 6-year cut-off point to define “new injectors” is based on prior research in New York City and elsewhere which has found that among IDUs HIV prevalence is lower for those injecting for 6 or fewer years (Friedman et al., 1989;Robles et al., 1992;Neaigus et al., 1996;Garfein et al., 1996). Thus new injectors represent a susceptible subpopulation of IDUs in which HIV infection may not be widespread, but in which the prevalence of HBV and HCV, and the risk factors for blood-borne and sexually transmitted infections in general, including HIV, may be considerable.

2.2 Measurement and variables

Participants were interviewed about their sociodemographic (age, gender, and race/ethnicity) and other background characteristics, whether they were in drug treatment (methadone maintenance, detoxification or other drug treatment), and their injecting and sexual risk behaviors and risk networks. Injecting and sexual risk variables measure lifetime risk, except for the characteristics of injecting risk networks (last 30 days) and sexual risk behaviors (last six months), for which lifetime data were not collected.

Lifetime injecting risk behaviors included: lifetime frequency of injecting; ever injecting specific drugs (e.g., heroin); ever engaging in receptive syringe sharing; ever sharing a cooker, cotton or rinse-water; ever engaging in receptive syringe-mediated drug-sharing; ever renting a syringe; ever injecting at a commercial multi-user setting (a “shooting gallery”); and ever sharing any injecting equipment (including both syringes and non-syringe injecting equipment used for drug preparation, such as cookers). Injecting risk network variables (based on participants’ responses to questions about the specific people with whom they injected in the prior 30 days) included injecting network size (the number of 30-day injecting risk network members) and having injecting risk network members who, for each characteristic separately: were infected with HIV, HBV or HCV; were men-who-have-sex-with-men (MSM); were known casually; were five or more years older than the participant; and who knew each other (a measure of social network density). This latter variable was derived by asking participants, for each pair of nominated injecting risk network members, whether the members knew each other.

Sexual risk variables included: engaging in unprotected vaginal sex; engaging in any anal sex; the lifetime number of sex partners; ever having sex risk network members who, for each characteristic separately, were: infected with HIV, HBV or HCV; were IDUs; and were MSM.

Ever selling sex for money or drugs, being a MSM, being a woman-who-has-sex-with-women (WSW), and ever having a sexually transmitted disease (STD) were treated as proxy variables for direct injecting or sexual risk exposures.

Several variables were treated as possible confounders of direct injecting and sexual risk exposures, including: the number of years since initiating injecting; age at injecting initiation; calendar year of injecting initiation; the number of years since initiating sexual activity; age at initiating sexual activity, non-white race/ethnicity; age; and ever being incarcerated in jail or a detention center.

Categorical variables were dichotomized as no/yes. Continuous and interval level variables with skewed distributions were dichotomized at the median.

2.3 Laboratory analyses

Blood specimens were tested for HIV-1 antibody (EIA with Western Blot confirmation (Abbott)), antibody to the hepatitis B core antigen (Abbott hepatitis B virus core antigen (recombinant) CORZYME immunoassay), and HCV antibody (Abbott HCV EIA 2.0). A positive test for the HBV core antibody indicates whether an individual has ever been infected with the pathogen and does not, by itself, indicate current infection. The HCV enzyme immunoassay test used in this study has a high positive predictive value of 100% when confirmed by supplemental testing (Abbott EIA 2.0 and HCV MATRIX) (Des Jarlais et al., 2003).

2.4 Statistical analyses

Statistical analyses were stratified by gender and conducted separately for each infection. Of 259 participants, five women and six men self-reported being vaccinated against HBV and were excluded from the analysis of the correlates of ever being HBV infected because it was not possible to determine if they were immune against HBV through being vaccinated (which requires the HBV surface antigen and surface antibody tests as well as the core antibody test). Since only seven participants were HIV infected, the analysis of the correlates of HIV infection was limited to assessing univariate associations.

The analysis of the sample characteristics used the chi-square test or Fisher's exact test for categorical variables, and the t-test for continuous variables. The univariate analyses of the risk correlates used the Wald chi-square to test the significance of individual logistic regression coefficients. Adjusted odds ratios (AOR) and 95% confidence intervals (95% CI) were estimated using multivariate logistic regression.

The multivariate models were developed using a sequential approach. First, injecting and sexual risk exposure variables that were $p < 0.20$ in univariate analysis were entered into multivariate models using backward elimination, with variables that were significant at $p < 0.05$ retained in the models. Second, possible confounders were tested by using stepwise selection against the retained injecting and sexual risk exposure variables. Finally, simultaneous multivariate analyses were conducted that included significant ($p < 0.05$) injecting and sexual risk exposure variables from the first step, significant confounders from the second step, and interactions between the retained sexual risk variables and ever sharing any injecting equipment. The interaction variables were created by stratifying the retained sexual risk variables by ever sharing any injecting equipment. If the sexual risk correlates remained significant among both those who ever shared any injecting equipment and those who did not, only the main effects for the sexual risk correlates are included in the final models. Statistical significance is two-sided at $p < 0.05$. All analyses were conducted using SAS v9.

3. Results

3.1 Sample characteristics

The majority (68%) of the 259 participants were male, and most (81%) self-reported being of white race/ethnicity. (Table 1) Males were significantly older than females. Approximately half were low income, homeless, and had not graduated high school. Two thirds had ever been incarcerated, with men significantly more likely to report incarceration. Few were currently in drug treatment.

On average, participants had initiated injecting 2.9 years prior to the interview and were 19.4 years of age at initiation; females initiated injecting at a significantly younger age. Almost all had ever injected heroin, while two-thirds had ever injected cocaine and over half speedball (a mixture of cocaine and heroin). Many had engaged in unsafe injecting, with a third ever engaging in receptive syringe sharing, and over half ever sharing any injecting equipment. The mean age of sexual initiation was 14.3 years. While a quarter self-reported same gender sexual experience, women were more likely to do so, and were also more likely to report ever selling sex. Other background characteristics, drug use behaviors and injecting risk behaviors are shown in Table 1.

Seven (2.7%) participants (three women and four men) tested HIV seropositive, while 20% and 32%, respectively, were seropositive for HBV and HCV, with men significantly more likely to test HBV seropositive, and women HCV seropositive. The most frequently co-occurring seropositive tests were for HBV and HCV. Among the seropositive, those who self reported ever being infected included 3 of 7 (43%) who tested HIV seropositive, 13 of 50 (26%) who tested HBV seropositive, and 31 of 83 (37%) who tested HCV seropositive.

3.2 Correlates of HIV, HBV and HCV seroprevalence

The univariate results of the correlates of HIV, HBV and HCV seroprevalence are shown in Table 2 (women) and Table 3 (men). In Tables 2 and 3 only variables that were significant at $p < 0.20$ for any of the three viruses are shown. Where the odds ratios could not be calculated because of zero cells or quasi-complete separation, the significance level is shown but the odds ratios are not applicable (N/A). Table 4 shows the results of the multivariate analysis of HBV and HCV seroprevalence, stratified by gender. For variables that are displayed in the tables as inversely associated, we have reported the results in the direction of an association with testing seropositive.

3.2.1 Univariate and multivariate analyses among women—Among women, ever selling sex was significantly ($p < 0.05$) associated with being seropositive for each of the three viruses. (Table 2) The other variables significantly associated with being HIV seropositive included injecting with MSMs, a higher lifetime number of sex partners, and never having had an IDU sex partner. Ever having had an infected (HIV, HBV or HCV) sex partner and a higher lifetime frequency of injecting were associated with being HCV seropositive. The univariate association of the interaction variable included in the final model for HCV among women is shown, in bold, in Table 3.

In the multivariate analysis, ever selling sex and ever having had an infected sex partner were independently associated with being HBV seropositive A higher lifetime frequency of injecting, and ever having had an infected sex partner (only for those who had *ever shared* any injecting equipment) were independently associated with testing HCV seropositive. (Table 4)

3.2.2 Univariate and multivariate analyses among men—Being a MSM and of non-white race/ethnicity were significantly associated with HIV infection among male new IDUs.

(Table 3) The variables significantly associated with testing HBV seropositive included a lower number of 30-day injecting network members, ever having had an infected sex partner, ever selling sex, being a MSM, ever having an STD, and initiating injecting more than two years prior to the interview. Ever injecting cocaine, ever injecting speedball, a higher lifetime number of sex partners, and ever having had an infected sex partner were significantly associated with testing HCV seropositive. The univariate association of the interaction variables included in the final model for HCV among men are shown, in bold, in Table 3.

In the multivariate analysis among men, ever selling sex and a lower number of 30-day injecting network members were independent correlates of testing HBV seropositive. (Table 4) The independent correlates of testing HCV seropositive included ever injecting speedball, never having had an IDU sex partner, a lower number of 30-day injecting network members, a higher lifetime number of sex partners (only among those who had *never shared* any injecting equipment), and ever having had an infected sex partner (only among those who had *ever shared* any injecting equipment).

A correlation analysis was conducted, within each stratum of ever sharing injecting equipment, to determine other sex risk factors that may be associated with the relationship of having a higher lifetime number of sex partners with testing HCV seropositive. The only significant result was among men who had *never shared* any injecting equipment, among whom having a higher number of sex partners was significantly correlated with ever selling sex ($r = 0.24$, $p < 0.03$). Moreover, among men overall, ever selling sex was strongly correlated with being a MSM ($r = 0.56$, $p < 0.001$).

3.2.3 Multivariate analysis of confounders—For both female and male new IDUs, none of the possible confounders were significantly associated with either HBV or HCV seropositivity in the multivariate analysis.

4. Discussion

In this study, very few new IDUs were infected with HIV, although HBV and HCV seroprevalence were considerably higher. This suggests that although HIV prevalence is currently low, many of the risk behaviors and risk network characteristics may exist for an HIV epidemic. There may also be gender differences in the rate of infection by different pathogens; while men were more likely to be seropositive for HBV, women were more likely to be seropositive for HCV.

Among women, ever having been HBV infected appears to be associated with sexual risk, including ever having had an infected sex partner and ever selling sex. While among women those with greater parenteral exposure were more likely to have been HCV seropositive, the evidence is less convincing for the sexual transmission of HCV, since the association of ever having had an infected sex partner with being HCV seropositive was significant only among those who had *ever shared* any injecting equipment. This suggests that among female new IDUs the risk of HCV infection from infected sex partners may be confounded and/or overlapping with sharing injecting equipment, since their sex partners may also be their injecting partners (Neaigus et al., 1995;Evans et al., 2003).

Among men, ever having been HBV infected is also associated with sexual risk, as indicated by ever selling sex. Moreover, among men ever selling sex is associated with being a MSM. Not surprisingly, men with greater parenteral exposure were also more likely to be HCV seropositive, since injecting speedball has been associated with greater injecting risk (Chaisson et al., 1989). The significant association of ever having had an infected sex partner with being HCV seropositive only among those who had *ever shared* any injecting equipment again

suggests, as with women, that the risk of HCV infection from infected sex partners may be confounded and/or overlapping with sharing injecting equipment with injecting partners who are also sex partners. By contrast, the significant association of having a higher lifetime number of sex partners with being HCV seropositive only among those who had *never shared* any injecting equipment suggests that there may be an independent sexual risk of HCV infection among male new IDUs. Among men, having a higher lifetime number of sex partners is associated with selling sex which, as discussed above, is associated with being a MSM. Although in this study being a MSM may have been underreported and weakened the association of being a MSM with being HCV seropositive, other studies have found that HCV infection among MSM is associated with sexual practices that may involve blood-to-blood transmission, such as unprotected receptive anal sex and receptive anal "fisting" (Ndimbie et al., 1996;Ghosn et al., 2004;Gambotti et al., 2005;Gotz et al., 2005).

The other correlates of testing seropositive among male new IDUs suggest that social network factors may increase as well as reduce risk. Males who have never had an IDU sex partner may have had large, high-turnover injecting networks comprised of acquaintances or strangers, and thereby may have had multiple exposures to HCV (Neaigus et al., 1994;Kral et al., 2001). By contrast, the protective effect of ever having had an IDU sex partner on being HCV seropositive suggests that heterosexual male new IDUs may be at reduced risk of HCV infection because of norms which prescribe that men go first when injecting equipment is shared with female injecting partners (Bennett et al., 2000;Evans et al., 2003). Once an infectious pathogen has entered a larger sociocentric IDU network (comprised of both direct and indirect ties between IDUs), having smaller egocentric injecting networks (the direct ties between an IDU and her/his injecting partners) imbedded within this larger sociocentric network may increase infection risk since high-risk injecting behavior is more likely to occur in smaller egocentric networks, in which strong norms of trust and reciprocity may encourage or reinforce unsafe injecting practices (Neaigus et al., 1995;Friedman et al., 1997;Strathdee et al., 1997). Since the effects of network factors on injecting and sexual infection risk among new IDUs, and IDUs in general, are complex, further study is warranted.

Although HIV seroprevalence was low, the distribution of infection across sociodemographic and sociobehavioral groups may help to identify which new IDU subpopulations are at greatest risk of becoming infected with HIV. Other studies in the United States have also found an increased risk for HIV among young and/or new IDUs who are African-American/black or non-white Hispanics (Neaigus et al., 1996;Holmberg, 1996;Friedman et al., 1999), MSM (Garfein et al., 1996;Des Jarlais et al., 1999;Kral et al., 2001;Strathdee et al., 2001;Shafer et al., 2002), sell sex (Kral et al., 2001), or who are WSWs (Friedman et al., 2003).

Interventions among new IDUs to prevent and control infection with HBV and HCV and to prevent HIV epidemics should include mass screening for these pathogens among new IDUs and expanded coverage of HBV vaccination programs to IDUs. Interventions should also target specific subpopulations that may be at greatest risk. Such interventions should focus on those who may be the most susceptible for becoming infected with HIV, and on new IDUs in overlapping injecting and sexual relationships. Since the overlap of injecting and sexual risk may be rooted in the intersection of IDUs' injecting and sex risk networks with their social support networks, especially among women (Miller and Neaigus, 2002), interventions are also needed that address underlying societal factors (e.g., unstable housing) that may lead new IDUs to seek out social support from other, potentially infected IDUs. Interventions are especially needed for primary prevention to prevent the initiation into injecting by non-injecting users of "hard" drugs, such as heroin, cocaine and other drugs (Neaigus et al., 2006).

The data have certain limitations. With cross-sectional data the temporal direction between infection and the risk correlates of infection cannot be determined. Participants may also have

been selective or inaccurate in their recall of lifetime risk exposures. Another limitation is that the variables measuring recent correlates are conservative estimates of lifetime infection risks. However, these limitations may have been minimized because participants were relatively short-term injectors and had been sexually active for a relatively short period of time. Participants' self-reports about their injecting and sex partners' risk characteristics depend on communication among partners about these characteristics and the factors influencing such communication. Nevertheless, engaging in injecting and/or sexual risk behaviors with known infected partners is a plausible risk for becoming infected with HIV, HBV and HCV. Although the tests used for HBV and HCV are indicators of ever being infected rather than current infection, for HCV it is estimated that between 60%–80% of infected adults testing seropositive for the HCV antibody are chronic carriers (Seeff, 2002). The findings also cannot be readily generalized to non-white new IDUs, and the relatively small sample of women may have limited statistical power to detect smaller significant differences among female new IDUs. While the methods used for sampling and recruiting in this study have also been used by many other studies of non-drug-treatment recruited drug users, the sample is non-random, so that generalizations from the study's findings must be informed by an understanding of the possible limitations of these sampling and recruiting methods.

As in many countries where HIV prevalence among new IDUs is currently low, many new IDUs in this study were or had been infected with HBV or HCV. Those with greater sexual risk exposure were at greater risk of ever being HBV infected, although parenteral transmission may also have occurred. Infection risk for HCV was through unsafe injecting and, possibly, high-risk sexual practices involving blood-borne transmission. Even in new IDU populations with low HIV prevalence, many new IDUs engage in injecting and sexual risk behaviors, and the outbreak of HIV epidemics cannot be ruled out should there be a change in the population probability of exposure to HIV. Early interventions among new IDUs are needed that combine mass screening for infection with these pathogens, information campaigns and HBV vaccination programs, along with interventions targeted at high-risk subpopulations of new IDUs to both prevent HBV and HCV epidemics and potential HIV epidemics.

Acknowledgements

The study was funded by the United States National Institute on Drug Abuse, grant DA09920 "Non-injecting heroin users, new injectors and HIV risk" (Principal Investigator: Alan Neaigus). We would like to thank Gilbert Ildefonso, Stephen J. Sifaneck, Peter Blasko, Jesse de Jesus and other members of the research staff for recruiting participants and data collection, as well as those who agreed to participate in the study.

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TABLE 1

Sociodemographic characteristics, drug use and sex risk history, and baseline seroprevalence of HIV, HBV, and HCV among new drug injectors 18–30 years old, New York City, February 1999 – February 2003

Characteristics	Total N (%)	Females N (%)	Males N (%)
Total	259 (100)	83 (100)	176 (100)
Race/ethnicity			
African-American/Black	5 (1.9)	3 (3.6)	2 (1.1)
Hispanic	30 (11.6)	9 (10.8)	21 (11.9)
White	209 (80.7)	65 (78.3)	144 (81.8)
Other	15 (5.8)	6 (7.2)	9 (5.1)
Age (mean (SD))	22.8 (3.3)	21.9 (3.2)	23.3 (3.2)**
Income in past 6 months less than $5000	129 (49.8)	45 (54.2)	84 (47.7)
Currently homeless	147 (56.8)	50 (60.2)	97 (55.1)
High school graduate	125 (48.3)	44 (53.0)	81 (46.0)
Ever incarcerated in jail or a detention center	169 (65.3)	44 (53.0)	125 (71.0)**
Currently in drug treatment	18 (6.9)	4 (4.8)	14 (8.0)
Years since initiating injecting (mean (SD))	2.9 (1.7)	2.8 (1.6)	3.0 (1.8)
Age at initiating injecting (mean (SD))	19.4 (3.6)	18.7 (3.6)	19.8 (3.6)**
Ever injected heroin	244 (94.2)	77 (92.8)	167 (94.9)
Ever injected cocaine	176 (68.0)	57 (68.7)	119 (67.6)
Ever injected speedball	153 (59.1)	48 (57.8)	105 (59.7)
Ever injected crack	57 (22.0)	16 (19.3)	41 (23.3)
Ever injected methamphetamines	30 (11.6)	10 (12.0)	20 (11.4)
Ever engaged in receptive syringe sharing	88 (34.0)	30 (36.1)	58 (33.0)
Ever shared cookers/cotton/rinse-water	129 (50.0)	48 (57.8)	81 (46.0)
Ever receptive syringe-mediated drug-sharing (e.g., backloading)	59 (22.8)	19 (22.3)	40 (22.7)
Ever rented syringes	8 (3.0)	1 (1.2)	7 (4.0)
Ever injected at a shooting gallery	30 (11.6)	7 (8.4)	23 (13.1)
Ever shared any injecting equipment	142 (54.8)	51 (61.4)	91 (51.7)*
Age at first sex (mean (SD))	14.3 (2.5)	14.5 (2.2)	14.2 (2.6)
Ever same gender sexual experience	66 (25.5)	40 (48.2)	26 (14.8)**
Ever sold sex for money or drugs	28 (10.8)	15 (18.1)	13 (7.4)**
HIV seropositive	7 (2.7)	3 (3.6)	4 (2.3)
HBV seropositive	50 (20.2)	9 (11.5)	41 (24.1)**
HCV seropositive	83 (32.0)	35 (42.2)	48 (27.3)**
HIV/HBV co-seropositive	4 (1.5)	1 (1.2)	3 (1.7)
HIV/HCV co-seropositive	4 (1.5)	1 (1.2)	3 (1.7)
HBV/HCV co-seropositive	34 (13.1)	8 (9.6)	26 (14.8)
HIV/HBV/HCV co-seropositive	3 (1.2)	1 (1.2)	2 (1.1)
HIV ever infected (self-report)	3 (1.2)	1 (1.2)	2 (1.1)
HBV ever infected (self-report)	20 (7.7)	4 (4.8)	16 (9.1)
HCV ever infected (self-report)	33 (12.7)	16 (19.3)	17 (9.7)
Vaccinated against HBV (self-report)	11 (4.2)	5 (6.1)	6 (1.0)

* $p<0.20$

** $p < 0.05$

TABLE 2

Univariate analysis of HIV, hepatitis B (HBV), and hepatitis C (HCV) seroprevalence among female new drug injectors, 18–30 years old, New York City, February 1999 – February 2003; p<0.20 for any infection

Variables	Total N	%	HIV+ OR	95%CI	%	HBV+ OR	95%CI	%	HCV+ OR	95%CI
Total	83	3.6			11.5			42.2		
Injecting risk behaviors (lifetime)										
Lifetime frequency of injecting										
< 300 times	30	3.3	Ref		6.9	Ref		16.7	Ref	
≥ 300 times	53	3.8	1.1	0.1–13.1	14.3	2.2	0.4–11.6	56.6	6.5	2.2–19.6**
Ever injected speedball										
no	35	8.6			14.7	Ref		42.9	Ref	
yes	48	0.0	N/A*		9.1	0.6	0.1–2.4	41.7	0.9	0.4–2.3
Ever injected crack										
no	67	4.5			14.3			41.8	Ref	
yes	16	0.0	N/A		0.0	N/A*		43.8	1.1	0.4–3.3
Ever injected methamphetamines										
no	73	4.1			13.0			38.4	Ref	
yes	10	0.0	N/A		0.0	N/A		70.0	3.8	0.9–15.7*
Ever receptive syringe-mediated drug-sharing (e.g., backloading)										
no	64	3.1	Ref		8.2	Ref		39.1	Ref	
yes	19	5.3	1.7	0.1–20.1	23.5	3.4	0.8–14.6*	52.6	1.7	0.6–4.9
Injecting risk networks (last 30 days)										
Injected with people who are MSM										
no	76	1.3	Ref		11.3	Ref		42.1	Ref	
yes	7	28.6	30.0	2.3–390**	14.3	1.3	0.1–12.3	42.9	1.0	0.2–4.9
Injected with people who are 5 or more years older										
no	58	3.4	Ref		9.1	Ref		36.2	Ref	
yes	25	4.0	1.2	0.1–13.5	17.4	2.1	0.5–8.7	56.0	2.2	0.9–5.8*
Sexual risk behaviors (last 6 months)										
Any anal sex										
no	65	3.1	Ref		13.1	Ref		50.0	Ref	
yes	18	5.6	1.8	0.2–21.7	5.9	0.4	0.0–3.6	40.0	1.5	0.5–4.3*
Sexual risk networks (lifetime)										
Lifetime number of sex partners										
< 40	70	1.4	Ref		9.2	Ref		41.4	Ref	
≥ 40	13	15.4	12.5	1.05–150**	23.1	3.0	0.6–13.8*	46.2	1.2	0.4–4.0
Ever had IDU sex partner										
no	10	20.0	Ref		10.0	Ref		40.0	Ref	
yes	73	1.4	0.1	0.0–0.7**	11.8	1.2	0.1–10.8	42.5	1.1	0.3–4.3
Ever had sex partner with HIV or HBV or HCV infection										
no	60	5.0			7.0	Ref		31.7	Ref	
yes	23	0.0	N/A		23.8	4.1	0.99–17.3*	69.6	4.9	1.7–14.0**
Injecting or sexual risk exposure proxy variables										
Ever sold sex										
no	68	0.0			7.8	Ref		36.8	Ref	
yes	15	20.0	N/A**		28.6	4.7	1.1–20.6**	66.7	3.4	1.1–11.2**
WSW										
no	43	0.0			7.3	Ref		48.8	Ref	
yes	40	7.5	N/A*		16.2	2.4	0.6–10.6	35.0	0.6	0.2–1.4
Reported ever having an STD										
no	47	0.0			8.7	Ref		42.6 Ref		
yes	36	8.3	N/A*		15.6	1.9	0.5–7.9	41.7	1.0	0.4–2.3
Possible confounder variables										

Variables	Total N	%	HIV+ OR	95%CI	%	HBV+ OR	95%CI	%	HCV+ OR	95%CI
Years since injecting initiation > 2										
no	45	4.4	Ref		14.3	Ref		35.6	Ref	
yes	38	2.6	0.6	0.1–6.7	8.3	0.5	0.1–2.4	50.0	1.8	0.8–4.4*
Non-white race/ethnicity										
no	65	1.5	Ref		13.1	Ref		46.2	Ref	
yes	18	11.1	8.0	0.7–93.8*	5.9	0.4	0.0–3.6	27.8	0.4	0.1–1.4*
Age <20 years										
no	60	3.3	Ref		14.3	Ref		48.3	Ref	
yes	23	4.3	1.3	0.1–15.3	4.5	0.3	0.0–2.4	26.1	0.4	0.1–1.1*
Interaction variables included in the final model ***(in bold)***										
"Ever shared any injecting equipment" and "Ever had sex partner with HIV or HBV or HCV infection"										
no/no(ref)	23	0.0	Ref		4.6	Ref		**34.8**	**Ref**	
no/yes	9	0.0	N/A		25.0	7.0	0.5–91.0*	**66.7**	**3.7**	**0.7–19.0***
yes/no	37	8.1	N/A		8.6	2.0	0.2–20.0	**29.7**	**0.8**	**0.3–2.4**
yes/yes	14	0.0	N/A		23.1	6.3	0.6–68.0*	**71.4**	**4.7**	**1.1–20.0****

* p<0.20

** p<0.05

N/A = Not applicable because of zero cell frequencies or quasi-complete separation of data points Ref = Reference category

TABLE 3

Univariate analysis of HIV, hepatitis B (HBV), and hepatitis C (HCV) seroprevalence among male new drug injectors, 18–30 years old, New York City, February 1999 – February 2003; p<0.20 for any infection

Variables	Total N	%	HIV+ OR	95%CI	%	HBV+ OR	95%CI	%	HCV+ OR	95%CI
Total	176	2.3			24.1			27.3		
Injecting risk behaviors (lifetime)										
Lifetime frequency of injecting										
< 300 times	66	4.5	Ref		21.5	Ref		24.2	Ref	
≥ 300 times	110	0.9	0.2	0.0–1.9*	25.7	1.3	0.6–2.6	29.1	1.3	0.6–2.6
Ever injected heroin										
no	9	0.0			22.2	Ref		0.0		
yes	167	2.4	N/A		24.2	1.1	0.2–5.6	28.7	N/A*	
Ever injected cocaine										
no	57	1.8	Ref		25.0	Ref		17.5	Ref	
yes	119	2.5	1.4	0.1–14.2	23.7	0.9	0.4–2.0	31.9	2.2	1.1–4.8**
Ever injected speedball										
no	71	4.2	Ref		20.0	Ref		16.9	Ref	
yes	105	1.0	0.2	0.0–2.1	27.0	1.5	0.7–3.2	34.3	2.6	1.2–5.4**
Ever injected crack										
no	135	3.0			21.1	Ref		25.2	Ref	
yes	41	0.0	N/A		35.1	2.0	0.9–4.5*	34.1	1.5	0.7–3.3
Injecting risk networks (last 30 days)										
Number of injecting network members > 2.4										
no	122	3.3			28.8	Ref		31.1	Ref	
yes	54	0.0	N/A		13.5	0.4	0.2–0.9**	18.5	0.5	0.2–1.1*
Sexual risk behaviors (last 6 months)										
Any anal sex										
no	150	2.0	Ref		24.3	Ref		25.3	Ref	
yes	26	3.8	2.0	0.2–19.6	23.1	0.9	0.3–2.5	38.5	1.8	0.8–4.4*
Sexual risk networks (lifetime)										
Lifetime number of sex partners										
< 40	123	2.4	Ref		20.5	Ref		22.8	Ref	
≥ 40	53	1.9	0.8	0.1–7.6	32.1	1.8	0.9–3.8*	37.7	2.1	1.02–4.1**
Ever had IDU sex partner										
no	36	5.6	Ref		25.0	Ref		36.1	Ref	
yes	140	1.4	0.2	0.0–1.8*	23.9	0.9	0.4–2.2	25.0	0.6	0.3–1.3*
Ever had sex partner with HIV or HBV or HCV infection										
no	146	1.4	Ref		20.4	Ref		22.6	Ref	
yes	30	6.7	5.1	0.7–38.0*	42.9	2.9	1.2–6.8**	50.0	3.4	1.5–7.7**
Injecting or sexual risk exposure proxy variables										
Ever sold sex										
no	163	1.8	Ref		21.0	Ref		25.8	Ref	
yes	13	7.7	4.4	0.4–46.0	61.5	6.0	1.8–19.6**	46.2	2.5	0.8–7.8*
MSM										
no	150	0.7	Ref		20.7	Ref		26.0	Ref	
yes	26	11.5	19.4	1.9–195**	44.0	3.0	1.2–7.3**	34.6	1.5	0.6–3.7
Reported ever having an STD										
no	146	1.4	Ref		20.4	Ref		26.7	Ref	
yes	30	6.7	5.0	0.7–38.1*	42.9	2.9	1.2–6.8**	30.0	1.2	0.5–2.8
Possible confounder variables										
Years since injecting initiation > 2										
no	89	2.2	Ref		16.3	Ref		22.5	Ref	
yes	87	2.3	1.0	0.1–7.4	32.1	2.4	1.2–5.1**	32.2	1.6	0.8–3.2*

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Variables	Total N	%	HIV+ OR	95%CI	%	HBV+ OR	95%CI	%	HCV+ OR	95%CI
Calendar year of initiation before 1997										
no	111	2.7	Ref		19.8	Ref		23.4	Ref	
yes	65	1.5	0.6	0.1–5.5	31.3	1.8	0.9–3.6*	33.8	1.7	0.9–3.3*
Non-white race/ethnicity										
no	144	0.0			23.0	Ref		25.0	Ref	
yes	32	12.5	N/A**		29.0	1.4	0.6–3.3	37.5	1.8	0.8–4.0*
*Interaction variables included in the final model **(in bold)***										
"Ever shared any injecting equipment" and Ever had sex partner with HIV or HBV or HCV infection"										
no/no(ref)	75	0.0	Ref		19.2	Ref		**22.7**	**Ref**	
no/yes	10	10.0	N/A		60.0	6.3	1.6–25.0**	**40.0**	**2.3**	**0.6–9.0**
yes/no	71	2.8	N/A		21. 7	1.2	0.5–2.6	**22.5**	**1.0**	**0.5–2.2**
yes/yes	20	5.0	N/A		33.3	2.1	0.7–6.6	**55.0**	**4.2**	**1.5–12.0****
"Ever shared any injecting equipment" and"Lifetime number of sex partners ≥ 40"										
no/no(ref)	62	1.6	Ref		18.3	Ref		**16.1**	**Ref**	
no/yes	23	0.0	N/A		39.1	2.9	1.0–8.3**	**47.8**	**4.8**	**1.6–14.0****
yes/no	61	3.3	2.1	0.2–23.0	22.8	1.3	0.5–3.2	**29.5**	**2.2**	**0.9–5.2***
yes/yes	30	3.3	2.1	0.1–35.0	26.7	1.6	0.6–4.6	**30.0**	**2.2**	**0.8–6.3**

* p<0.20

** p<0.05

N/A = Not applicable because of zero cell frequencies or quasi-complete separation of data points Ref = Reference category

TABLE 4

Multivariate analysis of risk correlates for testing seropositive for hepatitis B virus (HBV) and hepatitis C virus (HCV) among female and male new drug injectors 18–30 years old, New York City, February 1999 – February 2003 – final models

	HBV AOR (95%CI)	HCV AOR (95%CI)
Female		
Lifetime frequency of injecting – ≥ 300 times	-	**5.9 (1.9, 18.5)**
Ever sold sex	**5.2 (1.1, 24.6)**	-
Ever had sex partner with HIV or HBV or HCV infection	**4.5 (1.1, 20.3)**	
among those who never shared any injecting equipment	-	3.0 (0.62, 14.2)
among those who ever shared any injecting equipment	-	**5.7 (1.4, 23.0)**
Male		
Ever sold sex	**7.3 (2.1, 25.6)**	-
Ever injected speedball	-	**3.2 (1.4, 7.2)**
Ever had IDU sex partner	-	**0.37 (0.15, 0.91)**
Number of injecting network members in last 30 days > 2.4	**0.33 (0.13, 0.84)**	**0.33 (0.13, 0.83)**
Lifetime number of sex partners ≥ 40		
among those who never shared any injecting equipment	-	**3.9 (1.4, 11.1)**
among those who ever shared any injecting equipment	-	1.7 (0.6, 4.5)
Ever had sex partner with HIV or HBV or HCV infection		
among those who never shared any injecting equipment	-	1.8 (0.40, 7.8)
among those who ever shared any injecting equipment	-	**8.2 (2.7, 25.2)**